Temperature Dependent Photoemission Studies of Optimally Doped $Bi_2Sr_2CaCu_2O_8$

/ crossover from normal to superconducting state in (π,0) direction /

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Reference: *A.V. Fedorov et al., Phys. Rev. Lett. 82, 2179 (1999)*

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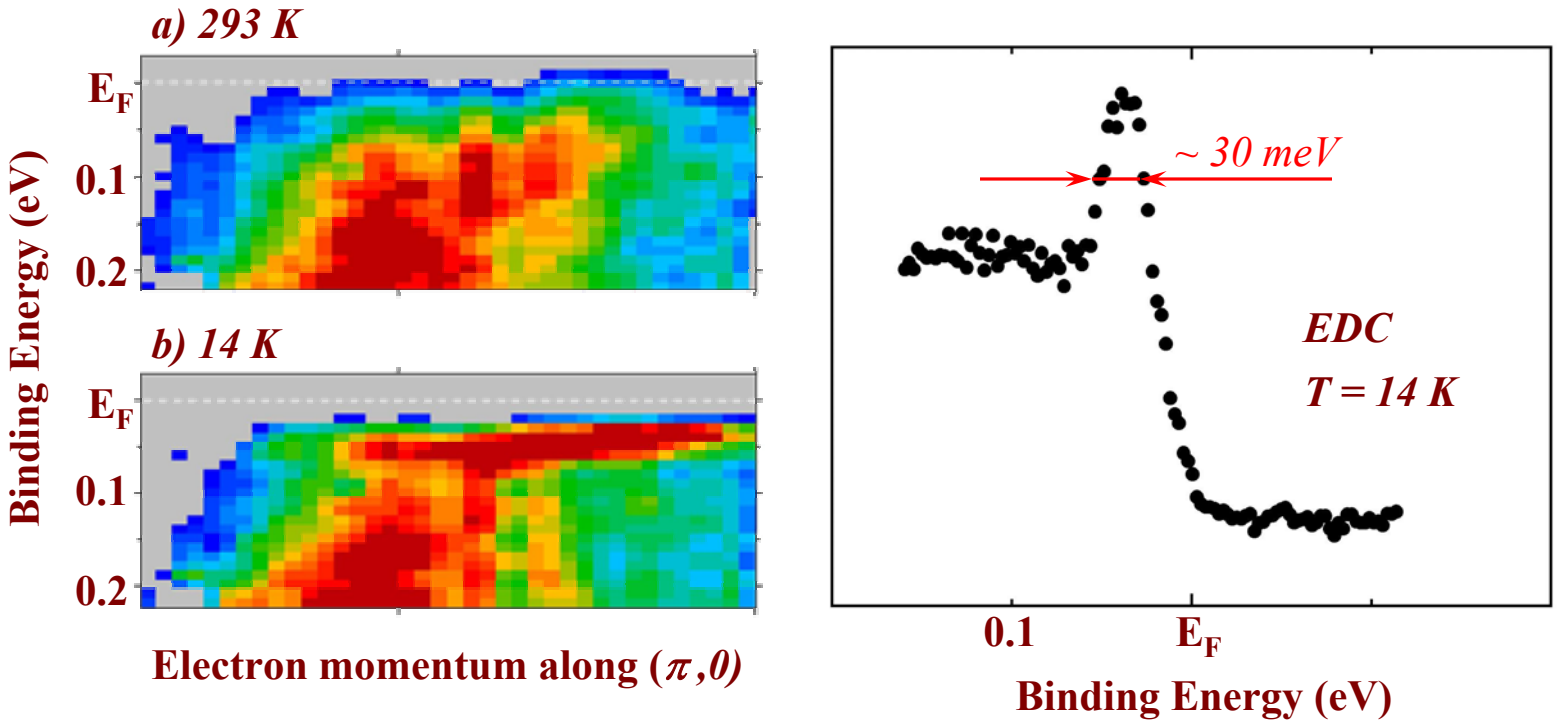
$Bi_2Sr_2CaCu_2O_8$

/ "resolution-limited" peak in superconducting state /

hν = 21.22 eV



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$Bi_2Sr_2CaCu_2O_{8+\delta}$, photoemission near $(\pi,0)$

/ influence of temperature, doping and impurities /

M.R. Norman et al., PRL 79, 3506 (1997)
/Argonne National Laboratory/

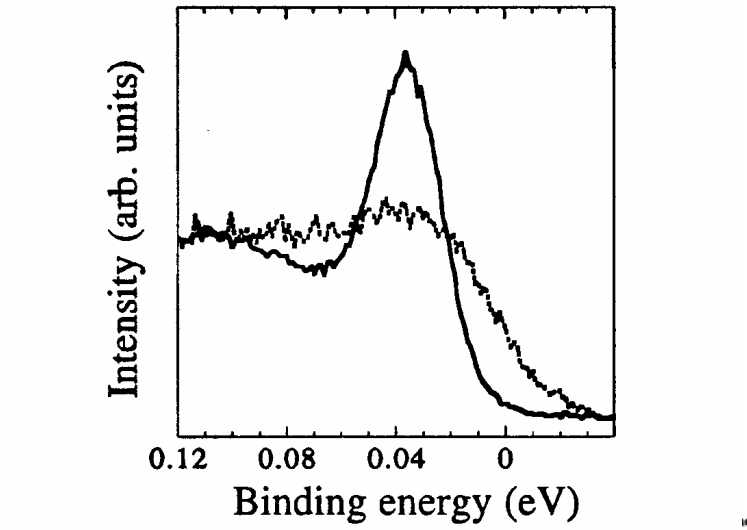

FIG. 1. Comparison of data at $\bar{M}$ in the normal state (105 K, dashed line) and the superconducting state (13 K, solid line) for a slightly overdoped (T_c = 87 K) Bi2212 sample with photon polarization $\Gamma - \bar{M}$.

P.J. White et al., cond mat/9901348
/Stanford University/

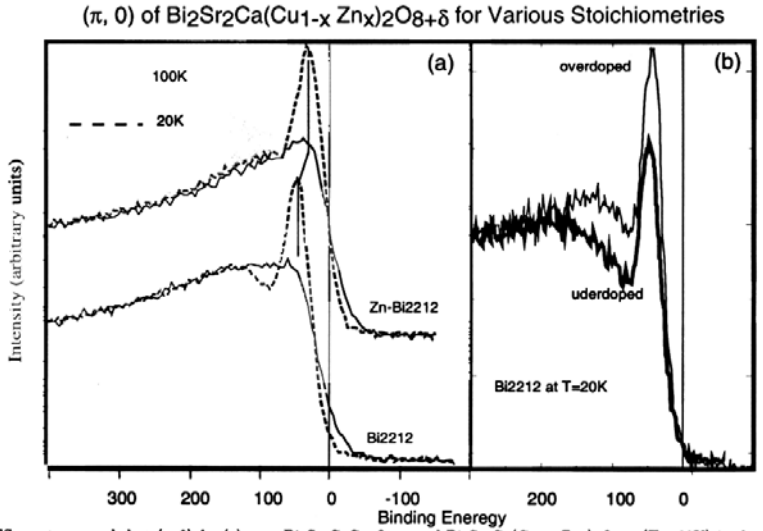

FIG. 3. ARPES spectra recorded at $(\pi,0)$ for (a) pure $Bi_2Sr_2CaCu_2O_{8+\delta}$ and $Bi_2Sr_2Ca(Cu_{1-x}Zn_x)_2O_{8+\delta}$ ($T_c \approx 83$K) in the normal and superconducting states. The dashed line is data recorded at 20K, and the solid line is data recorded at 100K and b) for underdoped and overdoped pure $Bi_2Sr_2CaCu_2O_{8+\delta}$.

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Experimental details:

- ✓ *Air-lock chamber with samples has been never backed over 100°C*
- ✓ *Samples cleaved in situ*
- ✓ *Samples mounted on an open-cycle He cryostat*
- ✓ *~ 10< TEMPERATURE (K)<~450*
- ✓ *Temperature monitored with a help of OMEGA CY7 sensor*
- ✓ *Typically it takes six hours to get angle-resolved spectra for ten temperatures*
- ✓ *Photon energy: 21.22 eV*
- ✓ *No effects of sample "aging" have been detected*

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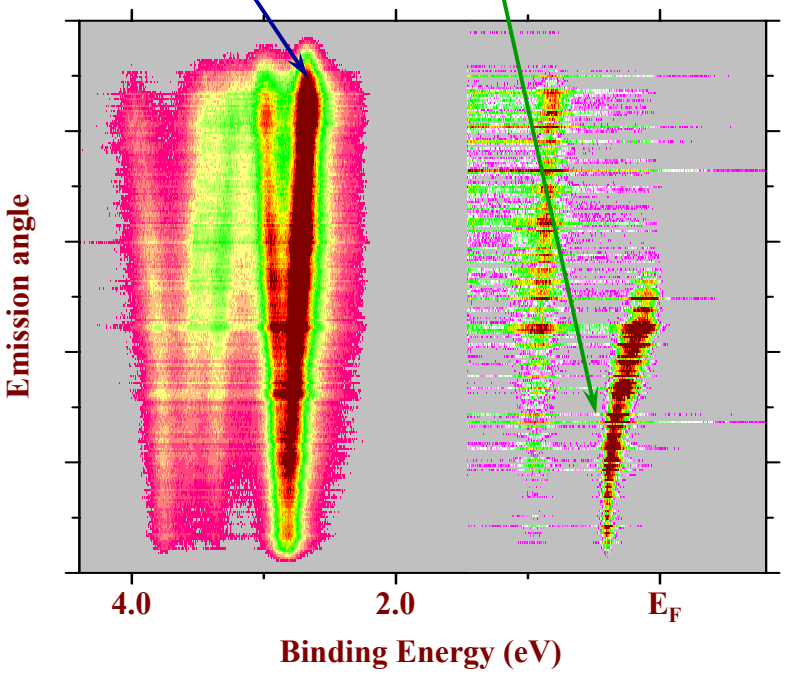
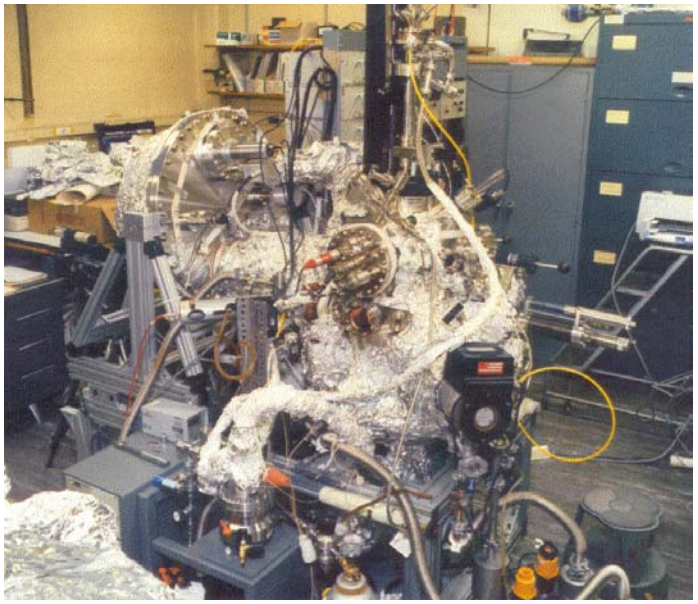
Photoelectron Spectrometer

SES-200: 200 millimeters hemispherical deflector capable of multichannel detection in emission angle and kinetic energy

Example of angle resolved data:

hν = 21.22 eV /He I radiation/
Cu(111), bulk bands and sp surface state





- ✓ *Energy resolution ~ 10 meV*
- ✓ *Angle resolution ~ 0.2 ^{o}*
- ✓ *Base pressure ~ 2× 10^{-11} Torr*

Presently located at the undulator beamline U13UB at the National Synchrotron Light Source

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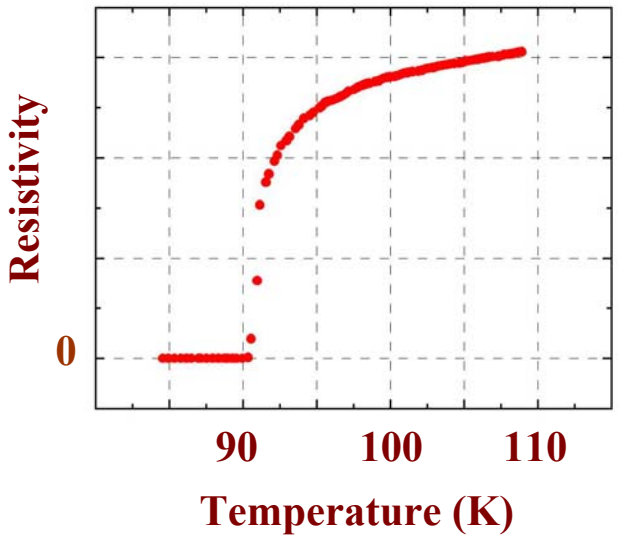
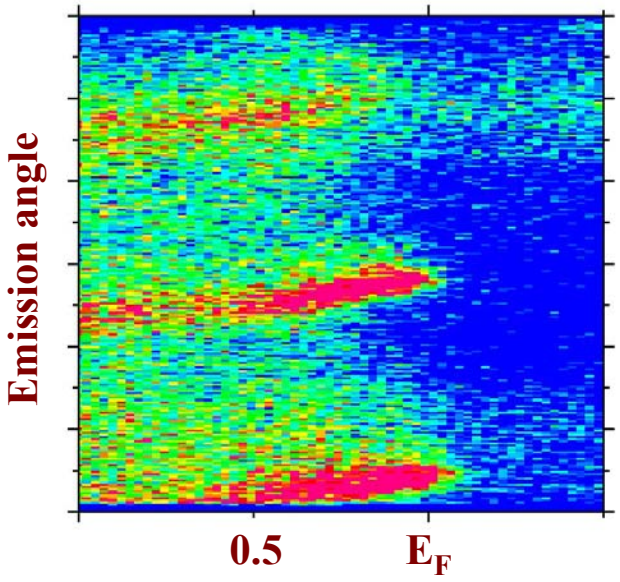
Sample quality

/ samples produced by floating zone method, $T_C = 91$ K /

a) Resistivity measurements



b) Umklaps in ΓY direction



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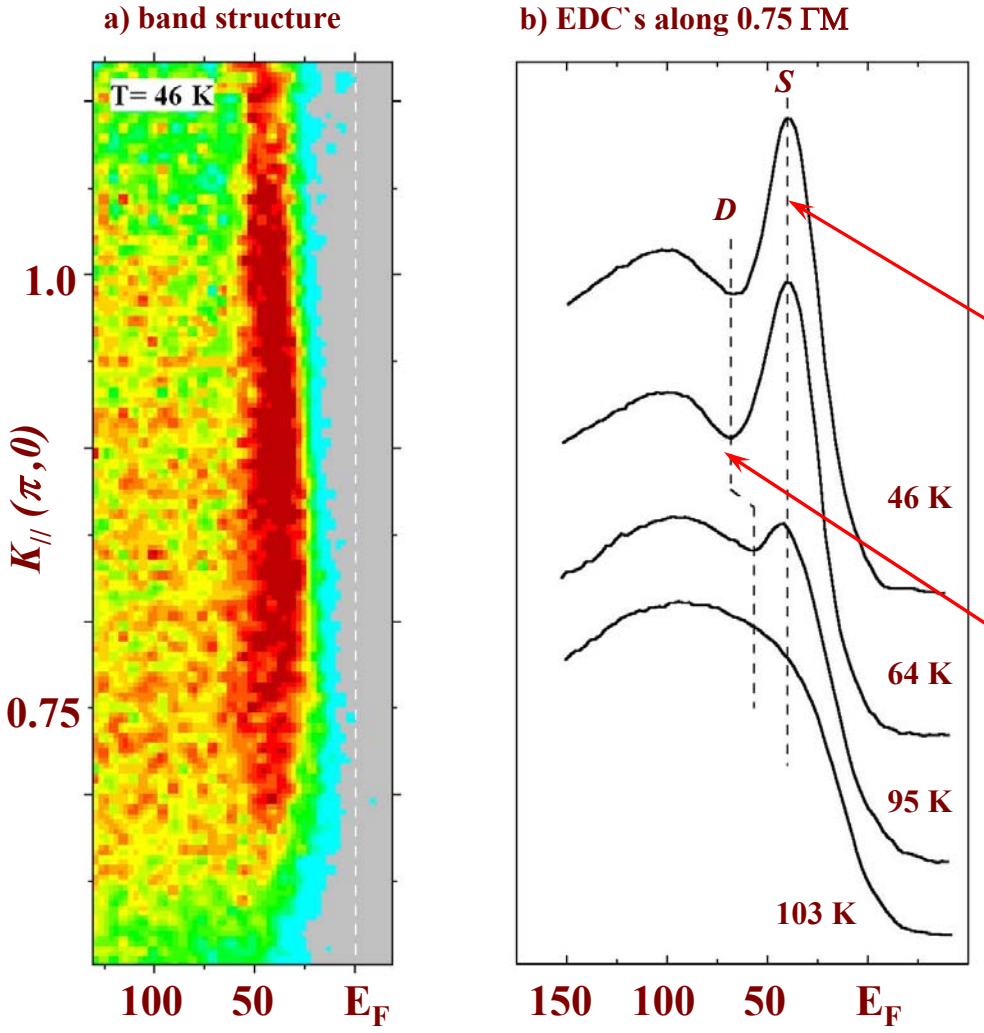
$Bi_2Sr_2CaCu_2O_8$
/present study/



"sharp peak" does not move with temperature;

it appears in the spectra above T_C

"dip" does move towards the Fermi level at ~ T_C

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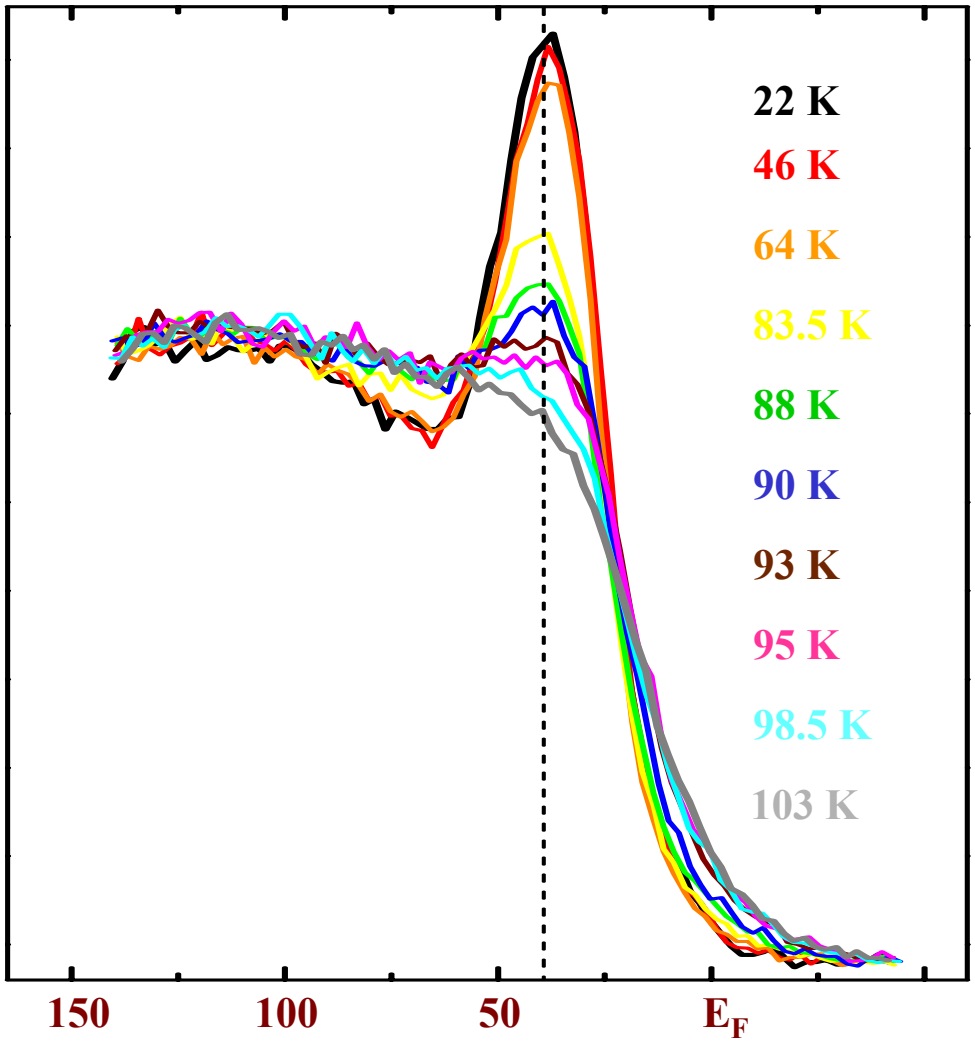
$Bi_2Sr_2CaCu_2O_8$

/angle-integrated data/



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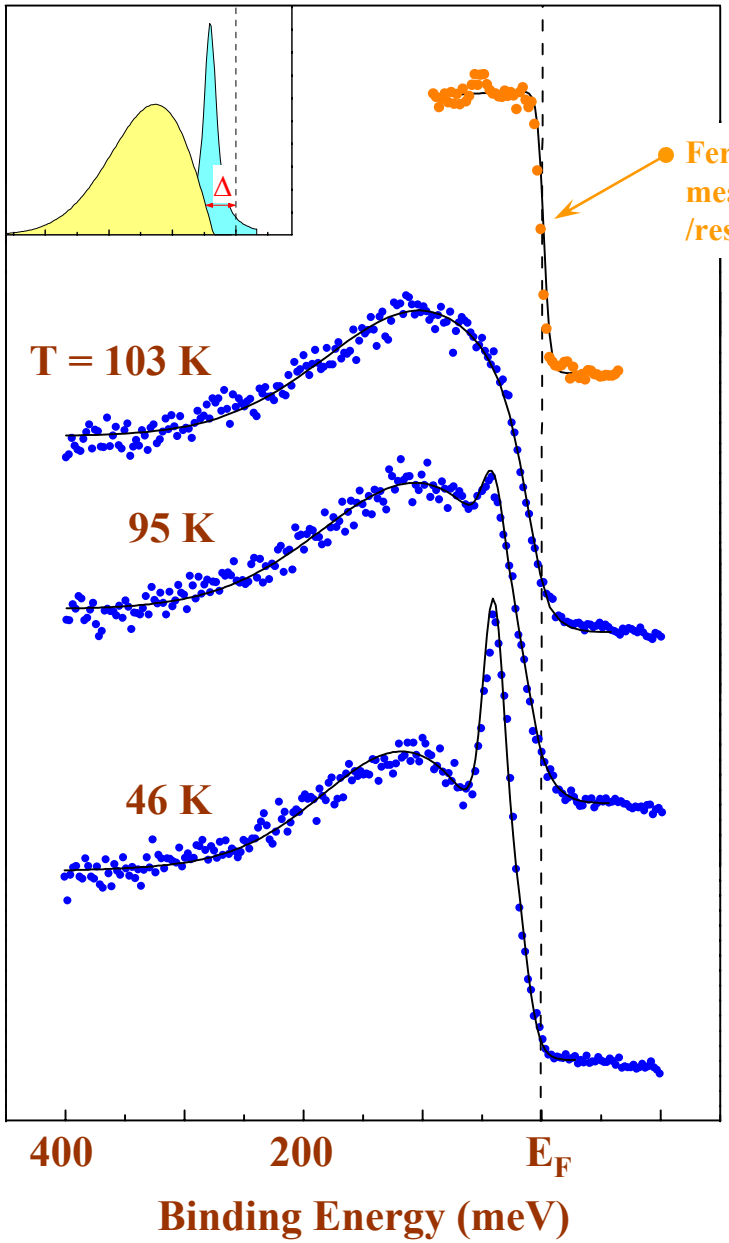
Fits to the data

/ 0.5° angle cuts at 0.75ΓM/ |



Sharp peak:

- ✓ *remains at the same binding energy ~ 40 meV;*
- ✓ *its width is constant, intrinsic width ~ 14 meV;*
- ✓ *it disappears at temperatures well above T_C*

Dip /leading edge of the broad peak/:

- ✓ *moves away from E_F at $T_C \Rightarrow$ gap opens;*
- ✓ *gap rapidly saturates if temperature is lowered below T_C*

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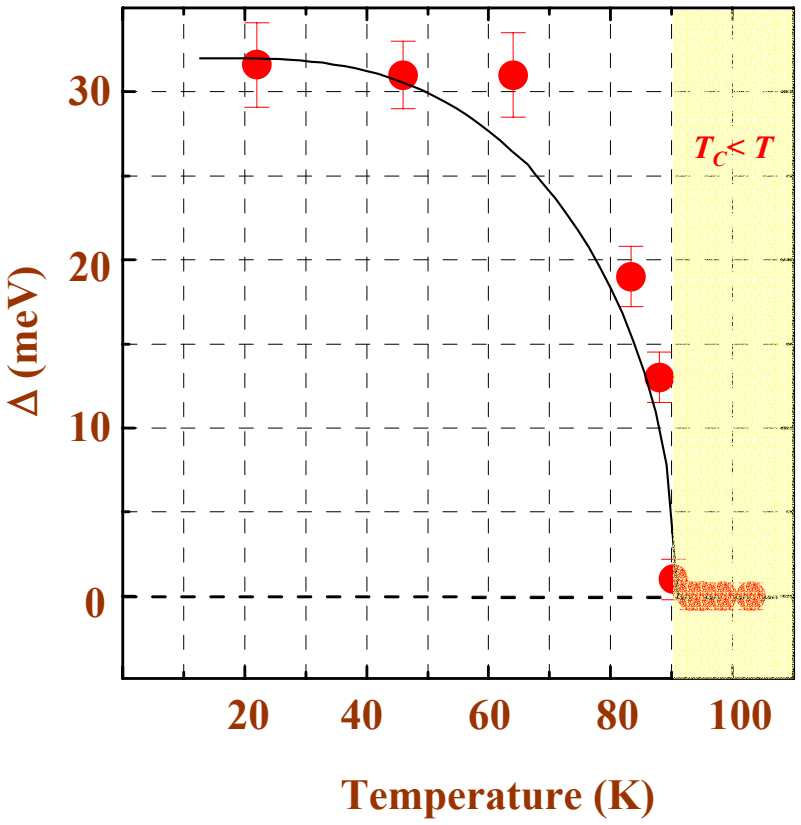
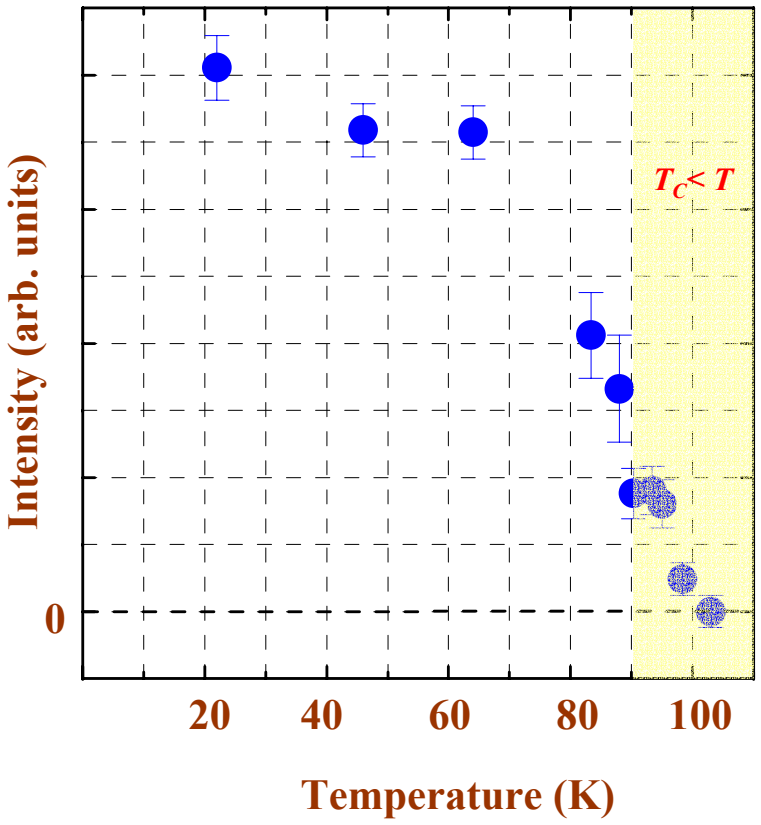
Conclusions

a) gap versus temperature



b) sharp peak versus temperature



It`s grate to have an instrument like that!

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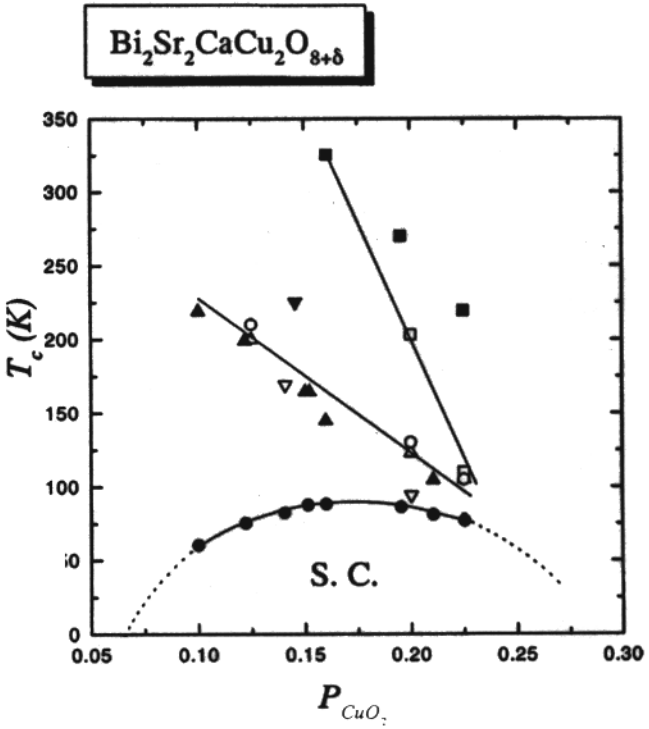

Pseudogap behavior in …

K.Ishida et al., Phys. Rev. B 58, R5960 (1998)

Optimal doping: T* = 130 K

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